

Docket No. 62,386

*Device and Method for Eliminating Adipose
Layers by Means of Laser Energy*

7 This application is a CIP of 08-798,516 filed 2-10-97.

FIELD OF THE INVENTION

The present invention relates to a device for eliminating adipose layers and to an associated technique for carrying out this elimination using the device.

BACKGROUND OF THE INVENTION

5 The reduction of subcutaneous adipose layers constitutes one of the most important areas of aesthetic treatments.

Two techniques currently exist for this purpose. The first technique, known as liposuction, consists of introduction into the adipose layers of probes roughly 5 mm in diameter through holes made in the skin of the patient undergoing treatment, for suction and removal of fat. This technique has a number of disadvantages, such as the creation of a lack of homogeneity in the form of depressions in the zone of insertion of the probe which are visible from the outside, as well as excessive bleeding of the patient undergoing treatment. Furthermore, both the cells of fat and the stroma are sucked out non-selectively.

The second technique utilizes subcutaneous ultrasonic probes to rupture the membrane of the adipose cells, thus causing the escape of liquid which then has to be sucked out subsequently. In this case, suction of the stroma is not brought about and bleeding is therefore more limited. However, the disadvantage of the lack of homogeneity of the treatment remains.

SUMMARY AND OBJECTS OF THE INVENTION

The primary aim of the present invention is to produce a device and an associated method for eliminating adipose layers which do not have the disadvantages mentioned above.

In particular, a first aim of the present invention is the production of a device and a method which allow uniform treatment.

A further aim is the production of a device and a method which allow selective elimination of the adipose cells without damaging the stroma.

Yet another aim of the present invention is the production of a device and a method which eliminate the problem of bleeding and which reduce the dimensions of the holes for insertion of the probes.

These and other aims and advantages, which will be clear to experts in the field from reading the text which follows, are obtained essentially with a device which comprises a first laser source, optical fiber conveying means for conveying the laser beam emitted by said first source, and a hollow needle for guiding the fiber. The fiber ends in the vicinity of the end of the needle. A laser source generates a laser beam through the optical fiber with an intensity and a wavelength for liquefying, and maintaining liquid, the adipose cells. The intensity and wavelength of the laser beam ruptures membranes of the adipose cells and maintains collagen in the adipose layer substantially unaltered or undamaged. Blood vessels in the adipose layer are either also substantially undamaged, especially the large blood vessels, or any blood vessels that are damaged are cauterized, especially the small blood vessels.

With this device, it is possible to implement a method for the reduction of subcutaneous adipose layers, on the basis of introducing into the subcutaneous adipose layers a laser beam at an intensity and at a wavelength which are such that the lipolysis of the adipose cells is brought about, that is a rupturing of the membranes of the cells themselves, with consequent transformation of the adeps into a liquid substance which is then sucked out or preferably left in place in order to be drained by the lymphatic system and by the action of the phagocytes of the patient. In addition to a clear reduction in traumatism and greater selectivity of the method implemented in this

manner in comparison with the liposuction system, the advantage is also obtained that the energy of the laser beam can be used to cauterize the small blood vessels which may be damaged by the insertion of the needle into the adipose layers. Loss of blood is thus virtually completely eliminated.

5 ~~Attached as an appendix to this application is an electronic microscope image of tissue treated with the method of the invention. There are three main elements in the area treated with the method of the invention:~~

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- A, a mass of adipose cells still to be subject to lysis;
 - B, hollow spaces where the adipose cells have been ruptured and the liquid generated by lipolysis has been removed by suction;
 - C. a structure of collagen fibers both in the space where adipose cells are still present as well as in the area where the adipose cells have been ruptured and removed.

15 The most important aspect to be highlighted in the area treated by the present invention, ~~and shown in the microscope image,~~ is the fact that the collagen fibers remain intact even where the adipose layer has been removed. The presence of the collagen structure is very important for the reconstruction of healthy (non-fatty) tissue in the area where the adeps has been removed.

20 Usual liposuction techniques remove by suction entire pieces of adipose tissue and together therewith they also remove portions of blood vessels and collagen fibers. Thus present liposuction intervention is heavily invasive. The area under the skin where the collagen fibers have been removed together with the adipose tissue shows

depressions and "sinkings" which are highly unaesthetic. Reconstruction of healthy (non-adipose) tissue in these areas is slow and unsatisfactory, due to the reduced vascularization and to the absence (or reduced presence) of collagen.

The method of the present invention is novel and advantageous over the art because it overcomes the above mentioned drawbacks. The method is mainly characterized in that the adipose tissue is removed by lysis, i.e. by rupturing the membranes of the cells forming the adipose layer. As a consequence, the adipose tissue is transformed into a liquid. The liquid thus obtained may be partially or totally suctioned away by means of a vacuum pump, quite in the same way as in the usual techniques. The difference is, however, the material removed through the suction cannula is substantially liquid and a much reduced impact on the patient is obtained. It is obviously easier and less painful to suck a liquid (generated by lipolysis) than pieces of adipose tissue which are solid. The collagen fibers and blood vessels are not damaged by the lysis effect of the laser and remain intact. The subsequent suction does not suck the collagen fibers nor the blood vessels away, as it happens in the traditional liposuction techniques. Subsequent recovery of the healthy tissue is easier.

As an alternative the liquid substance is left inside the body of the patient. In this case the liquid obtained by lysis of the adipose cells is slowly re-absorbed through the organism of the patient himself, namely through action of the lymphatic system and the phagocytes. This second method is slower than the former one, but is even less invasive and less traumatic.

In practice, the needle is borne by a hand unit which, in order to be more easily

maneuverable, is inclined in relation to the needle.

In addition to a laser source which emits at a wavelength and at a power which are such that lipolysis is brought about, it is possible, with the same optical fiber, or with an additional optical fiber guided in the same needle, to convey into the adipose layers a beam of visible light which makes possible transcutaneous vision during implementation of the method.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is a diagram of the device;

Fig. 2 is an enlarged longitudinal section view of the hand unit of the device in Fig. 1;

Fig. 3 is an enlarged view of the point of the needle, and

Fig. 4 is a view of the device being used in an example of application.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference initially to Fig. 1, the device comprises a laser source 1 of the

NdYAG type, with which an optical fiber 3 is associated, which conveys the energy of the source 1 toward a hand unit 5 equipped with a hollow guide needle 7 with a beveled end (Fig. 3). The needle has an external diameter of, for example, roughly 1 mm. The terminal end 3A of the optical fiber 3 ends at the point of the needle. The laser source 1 generates a laser beam through the optical fiber 3 with an intensity and a wavelength for liquefying, and maintaining liquid, the adipose cells. The intensity and wavelength of the laser beam ruptures membranes of the adipose cells and maintains collagen in the adipose layer substantially unaltered or undamaged. Blood vessels in the adipose layer are either also substantially undamaged, especially the large blood vessels, or any blood vessels that are damaged are cauterized, especially the small blood vessels.

In the example illustrated, the needle has an inclination in relation to the hand unit 5 of roughly 10-30 degrees and preferably 15-20 degrees to facilitate its use.

In Fig. 2, a possible system of fixing the fiber 3 can be seen, which comprises an elastic sleeve 11 accommodated in a seat 13, through which the fiber 3 passes and which is clamped by means of a threaded ring nut 15.

In the example illustrated, the device comprises a second laser source 21 which emits radiation in the visible range which is conveyed by means of a second optical fiber 23 to a connector 25, in which the visible radiation emitted by the laser 21 is introduced into the fiber 3. In this manner, the optical fiber 3 conveys to the point of the needle 7 a laser beam in the visible range also which allows the operator, in reduced ambient light, to follow accurately (by transcutaneous vision permitted by the

transparency of the skin) the position of the end of the fiber and therefore to control the instantaneous point of application of the laser energy generated by the source 1.

The laser source 1 emits a beam which is preferably pulsed, at a wavelength between 0.75 and 2.5 micrometers, for example at 1.06 micrometers, with an energy level between 30 and 300 mJoules per pulse. The wavelength is preferably between 0.8 to 1.1 micrometers and the pulse frequency is between 10 and 60 Hz, preferably between 30 and 50 Hz and most preferably around 40 Hz.

The device described above is used by inserting the fiber subcutaneously into the patient, in the adipose layer to be eliminated. The end of the fiber 3 thus comes directly into contact with the adipose layer. The laser beam, in the appropriate dosage, brings about the rupturing of the membranes of the adipose cells and at the same time cauterizes the very small veins contained in the stroma, which can be easily damaged by the penetration of the needle 7. In this manner, the adeps becomes liquid and at the same time a local hemostasis is created. The liquefied fat is then absorbed by the body by lymphatic drainage and the action of the phagocytes, while subsequent intervention, similar to that carried out in the case of treatment with ultrasonic probes, to remove the liquefied fat is also possible.

In practice, the needle 7 is provided with a skin cutting tip and used to cut or pierce the skin of the patient. The needle is initially inserted subcutaneously and is then moved forward and backward by the operator to irradiate the adipose cells and cause lipolysis of the adipose layer and rupture membranes of the cells forming the adipose layer, thus transforming adeps forming the adipose layer into a liquid

substance. The laser beam is generated and the irradiating performed to maintain the adipose cells as a liquid substance. The time which is necessary for the above depends on the characteristics of the tissue which is easily determined by the operator. Typically, to achieve the lipolysis of an adequate quantity of adipose cells, treatment with an energy level of 100 mjoules for a time of 200 microseconds per pulse is appropriate. The needle is kept in each penetration hole for a few minutes.

The liquid substance can then be removed by suctioning said liquid substance away from the adipose layer through a passage in the device or by another tool inserted through the skin of the patient. In another embodiment of the present invention the needle is removed from the patient leaving the liquid substance in the patient. The liquid substance is then left to be absorbed through elements of the patient adjacent the adipose cells, namely through the lymphatic system and phagocytes of the patient.

The movement of the point of the needle is easily controlled by means of the transcutaneous vision allowed by the visible laser beam generated by the second source 21. Lipolysis action is thus brought about in a certain portion of tissue. By extracting the needle and inserting it subcutaneously in an adjacent position, a subsequent portion of tissue is treated. From one and the same entry hole, the needle 7 can be inserted in various radial directions, treating an entire area of the tissue, as can be seen in Fig. 4, where 31 indicates in broken lines as a guide the insertion lines of the needle 7.

The end part of the needle 7 can be knurled in order to cause, during penetration of the adipose layers, a rupturing of the adipose cells and therefore in order to obtain greater effectiveness of treatment. In Fig. 3, the knurling is indicated

diagrammatically by Z.

It is intended that the drawing shows only an example given only by way of practical demonstration of the invention, it being possible for the invention to vary in form and arrangement without moreover leaving the scope of the concept which forms the invention itself.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.